

M234 / M235 / M236 SELF-DESTRUCT FUZES

THE 39TH ANNUAL GUN & AMMUNITION/ MISSILES & ROCKETS CONFERENCE



communications

KDI Precision Products, Inc.



APRIL 2004



OUTLINE

- Self-Destruct (SD) Fuze Objectives
- SD Fuze Requirements
- KDI SD Fuze Design and Operation
- Safety Test and Army Certification
- Type Classification Test Results
- High Rate Fuze Equipment Status
- High Rate Battery Equipment Status
- Product Improvements
- SD Fuze Schedule
- Summary

SD Fuze Objective

- Reduce the Number of Hazardous DPICM Grenade Dud Submunitions on the Battlefield

Advantages:

- ➡ Enables Maneuverability
- ➡ Reduces Clean-up Efforts
- ➡ Addresses Humanitarian Issues

U.S. Army SD Fuze Requirements

- Artillery (M234)
 - 97% Primary Mode (Ground Impact)
 - 99.8% Tactical Mode (Includes SD Function)
- ER-MLRS (M235)
 - Less Than 1% Hazardous Duds
 - Less Than 5% UXO (Fly-Off Requirement)



KDI's SD Fuze Key Design Feature

- Two Autonomous Fuzing Systems
 - PD Primary
 - Electronic Time SD
- Mechanical Arming of Primary Fuze Not Required to Arm SD Fuze
- Only SD Fuze Type Classified for U. S. Army and U. S. Navy Utilization

105 MM	→	ERGM	→
5" 54	→	XM982	→
ER-M	→	GMLRS	→

Background Fuze Operation

- SD Fuze Replacement for M223 Designed to Reduce the Number of Submunition Duds
- Minor Differences Between Artillery and MLRS Fuze
- Primary Mode of Operation
- Self-Destruct (Secondary) Mode of Operation

Self-Destruct Fuze Operation



1



2



Safety Testing

- MIL-STD-331-B Testing ✓
 - Detonator Out-of-Line Testing ✓
 - New Shunt Design / Testing ✓
 - E3 Testing ✓
 - Power On Reset ✓
 - Grenade Stack Test ✓
 - Propagation Test ✓
- EOD Issues ✓
 - Ribbon Color
 - Battery Bleed Down
 - Energetics Compatibility ✓
 - Approved Fuze Fault Tree ✓
 - MIL-1316 Checklist ✓

Army Certifications

- M234 Type Classified 24 Mar 98
- M235 Type Classification Paperwork in Process
- M236 Passed U.S. Army Safety Certification Firings
- Approved Fuze Fault Tree
- Approved MIL-1316 Checklist
 - Waiver For Stored Energy Granted
- M234/235 Granted AFSRB Final Safety Certification
- Fuze Line Qualification Planned For 4th Quarter 2003
- Fuze First Article Planned For 4th Quarter 2003

M234 SD Fuze Artillery Test Result

<i>TEST</i>	<i>CONFIGURATION</i>			
	<i>Primary Only</i>		<i>Tactical</i>	
Grenade Functioning	(30/2585)	98.84%	(3/1439)	99.79%
Air Drop	(21/1081)	98.0%	(0/156)	100%
Initial Safety & Sequential	(193/8125)	97.4%	2/1350)	99.9%
DT&E Total		97.6%		99.83%



M235 SD Fuze MLRS Test Results

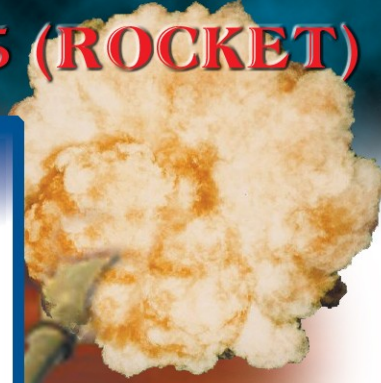
DVT TESTING

<i>Temperature / Range</i>	<i>Reliability</i>	
Hot @ 48Km	(5/461)	98.9%
Ambient @ 25Km	(2/1014)	99.8%
Cold @ 16Km	(9/1012)	99.1%
Weighted Mission Total:		99.52%

FOR VALIDATION, CALL:
AMSTA-AR-FSA-P
MR. Leon Springer
(973) 724-2208



SELF-DESTRUCT FUZES M234 (ARTILLERY) / M235 (ROCKET)



SAFETY SPIRAL
FLAG

SAFETY
SPIRAL

RIVET

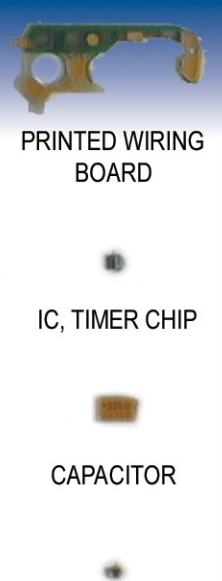


ARMING
SCREW

SAFETY CLIP

HOUSING

WEIGHT

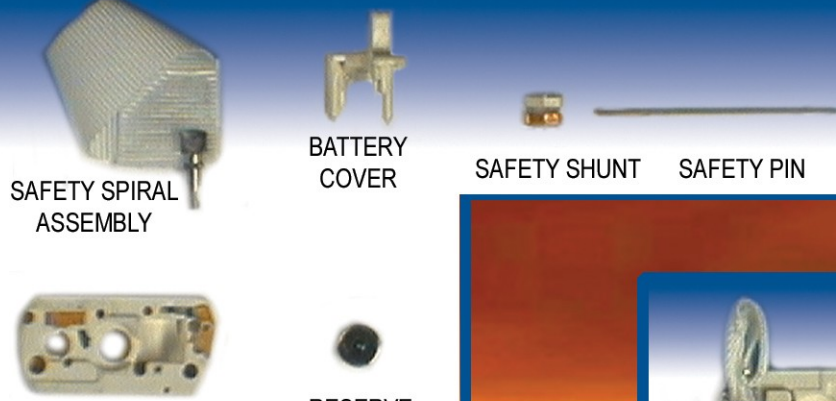


PRINTED WIRING
BOARD

IC, TIMER CHIP

CAPACITOR

CAPACITOR



SAFETY SPIRAL
ASSEMBLY

BATTERY
COVER

SAFETY SHUNT

SAFETY PIN

SLIDE SUBASSEMBLY

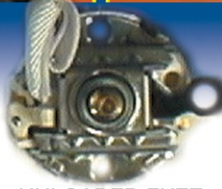
RESERVE
BATTERY



HOUSING ASSEMBLY



SLIDE ASSEMBLY



UNLOADED FUZE
ASSEMBLY

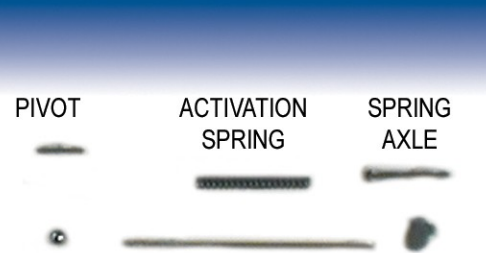


LOADED FUZE
ASSEMBLY



TAPERED BALL
SLEEVE

WIRING BOARD
ASSEMBLY



PIVOT

ACTIVATION
SPRING

SPRING
AXLE

SAFETY
BALL

SAFETY
PIN

LEVER



ARMING SPRING

SHOCK POST

COVER



EED
COVER

EED

M55 STAB
DETONATOR



Self-Destruct Fuze Assembly Line

PALOMAR PRODUCTS CHIP ON BOARD



Base Machine 1



Shunt Assembly Machine



Base Machine 3



Base Machine 2



QSI Slide Sub-Assembly
Molding Machine



Palomar Products Chip on Board Printed Wiring Board (PWB) Assembly (Machine) Status



PRINTED WIRING
BOARD



IC, TIMER CHIP



CAPACITOR



CAPACITOR

PALOMAR PRODUCTS CHIP ON BOARD



TAPERED BALL
SLEEVE



WIRING BOARD
ASSEMBLY



Printed Wiring Board (PWB) Assembly (Machine) Status

- **Palomar Line**
 - Palomar Line Has Been Accepted a Rate
 - Palomar Line Is Production Ready

Slide Subassembly Machine



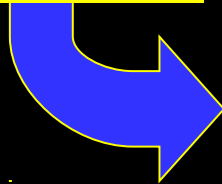
SLIDE ASSEMBLY



TAPERED BALL
SLEEVE

WIRING BOARD
ASSEMBLY

SLIDE ASSEMBLY MACHINE

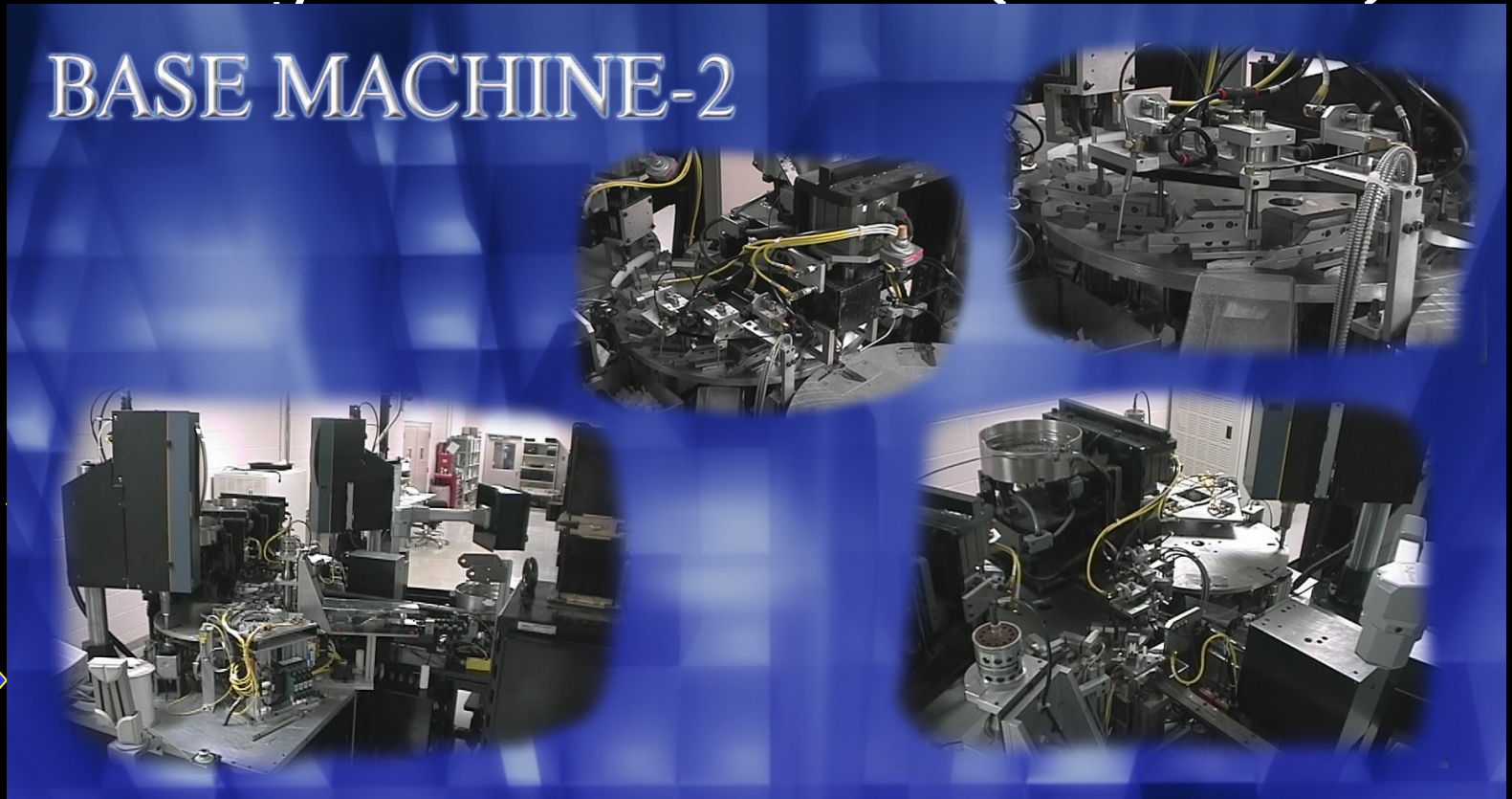
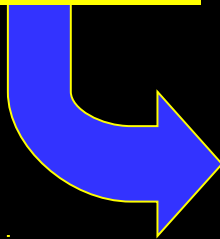
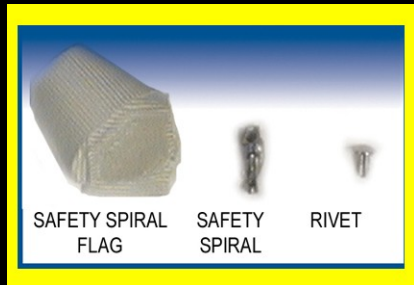


Slide Subassembly Machine Status

- QSI Machine
 - QSI Line Has Been Accepted at 100% rate
 - QSI Line Is Production Ready

Spiral Safety Flag Assembly Machine (BM-2)

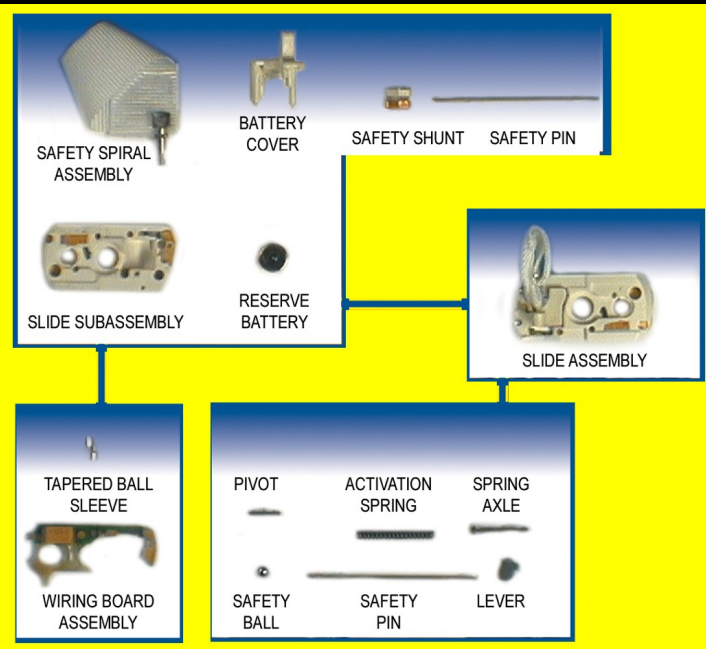
BASE MACHINE-2



Spiral Safety Flag Assembly Machine

- Base Machine #2 (BM-2) Status Tilted Spiral Flag Assembly
 - BM-2 Has Been Accepted at 100% Rate
 - BM-2 Is Production Ready

Slide Assembly Machine (BM-1)



BASE MACHINE-1

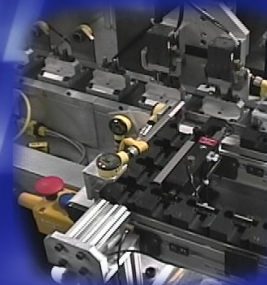
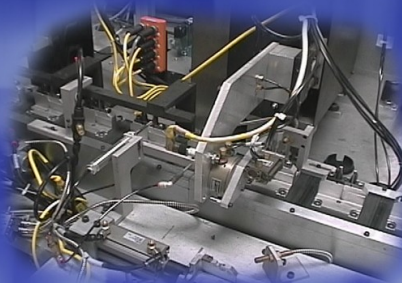


Slide Assembly Machine (BM-1) Status

- Base Machine #1 (BM-1) - Slide Assembly
 - BM-1 Has Been Proven Out at Rate
 - BM-1 Meets Product Quality Requirements
 - Final Acceptance Is Scheduled for First Quarter 2004
 - Final 100% Acceptance Is Prior to 200,000 Production Units

Unloaded Fuze Assembly Machine (BM-3)

BASE MACHINE-3



ARMING
SCREW



SAFETY CLIP



HOUSING



WEIGHT



HOUSING ASSEMBLY



SLIDE ASSEMBLY



UNLOADED FUZE
ASSEMBLY

ARMING SPRING

SHOCK POST

COVER

Unloaded SD Fuze Assembly Equipment Status (BM-3)

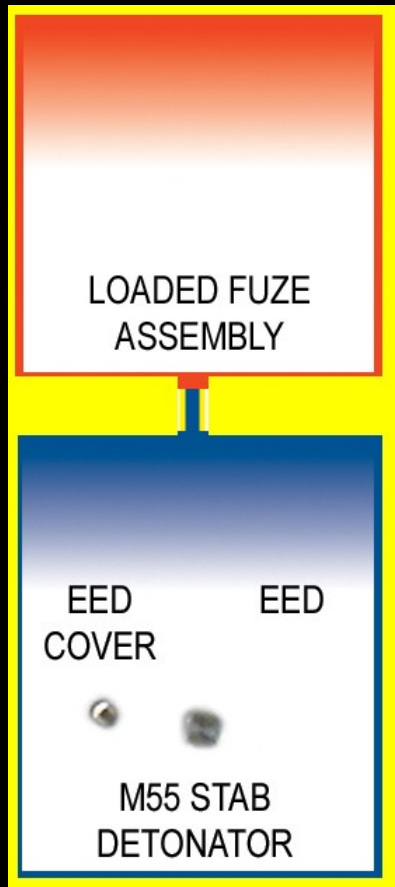
- Base Machine #3 (BM-3) - Fuze Assembly
 - BM-3 Has Been Accepted at 96% Rate
 - BM-3 Final Acceptance Will Be First Quarter 2004
 - BM-3 Is Production Ready

Shunt Assembly Machine Status

- Proven Out at Datum At 100% Rate
- Shunt Machine is Production Ready



SDF Loading Equipment

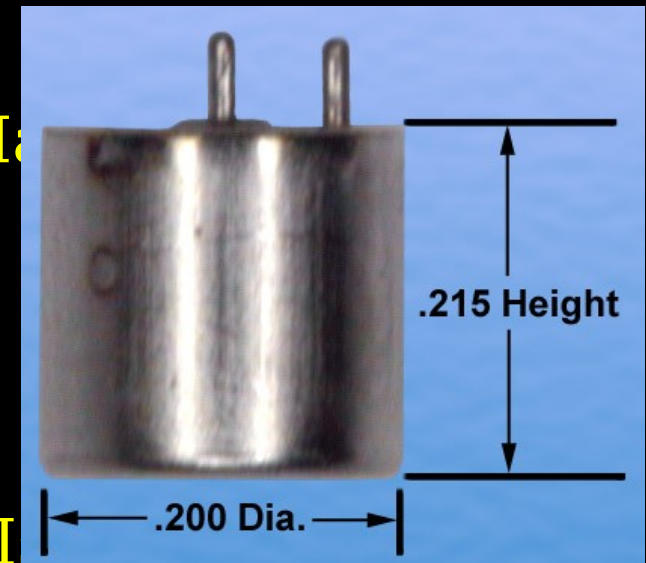


SDF Loading Equipment Status

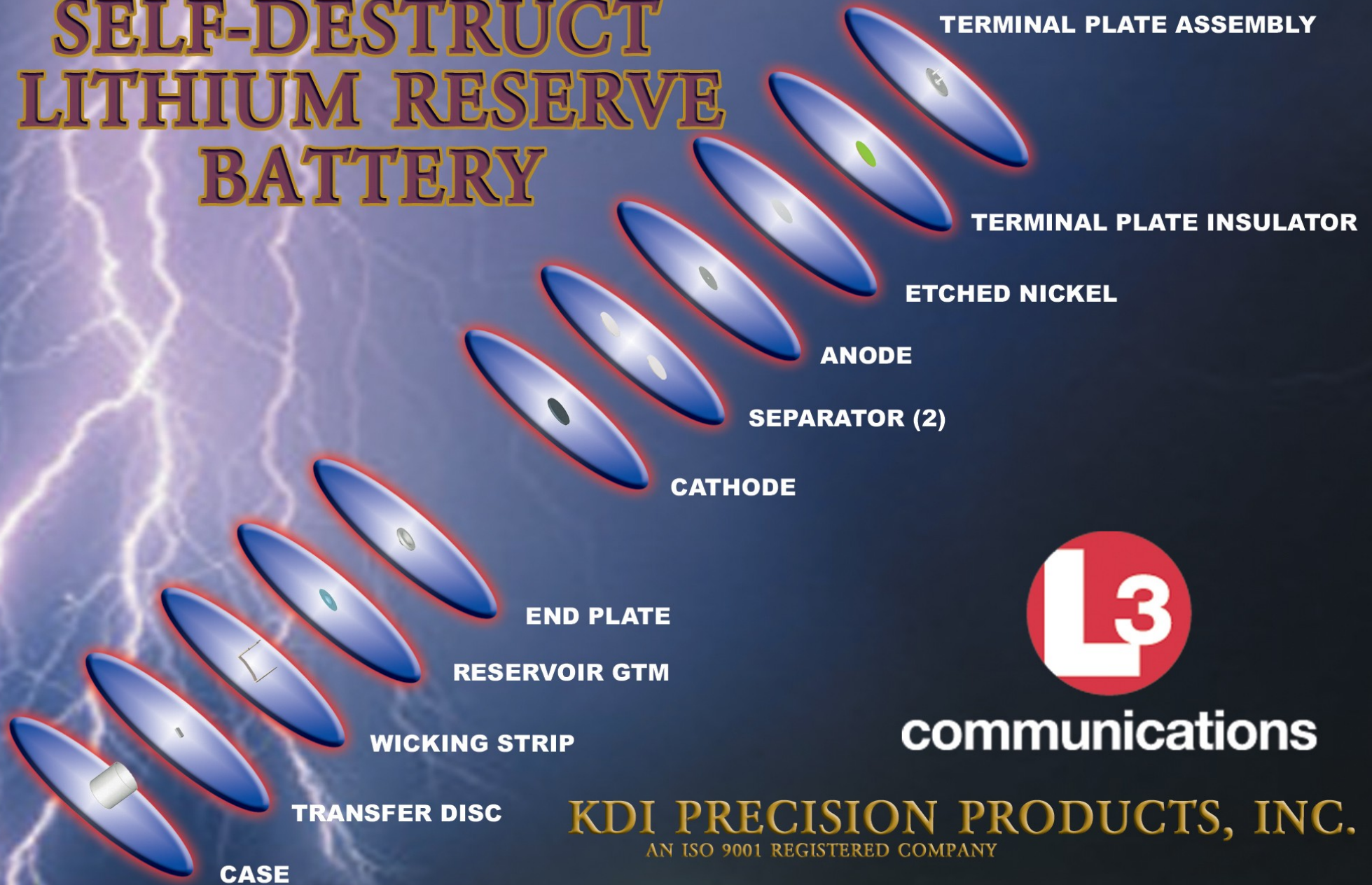
- SDF Loading Equipment Has Been Proven Out at 75% Rate
- Final Acceptance Is Scheduled for First Quarter 2004
- Equipment Production Ready

Lithium Reserve Battery Line

- Battery Design Was Completed by ATK and Qualified
- High Rate Equipment Was Not Acceptable
- New Equipment Has Been Purchased From RD Systems
- Contract Awarded To RD Systems in May
- Battery Line Was Installed At KDI in August 2003 (In Debug)
- KDI Has Retained THALES USFA, Netherlands to Consult on All Battery Issues



SELF-DESTRUCT LITHIUM RESERVE BATTERY

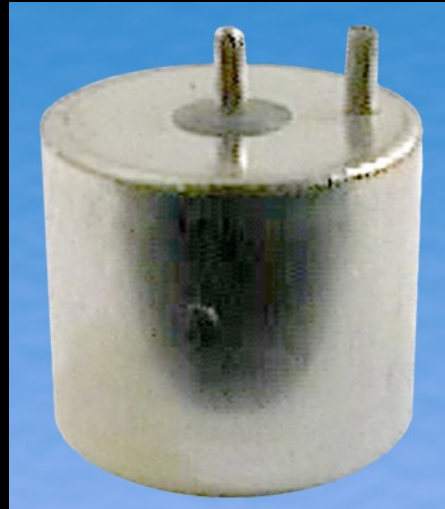


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AN ISO 9001 REGISTERED COMPANY



SDF Battery Animation



Lithium Reserve Battery

- Contract Structure
- Unique Battery HRE Contract
 - Preliminary Design Review (PDR)
 - Ampule Fill & Seal (Process)
 - Lithium Lamination Process
 - Brainstorming Review
 - Critical Design Review
 - Each Machine/Process
 - Release Component Fabrication
 - Proveout at RD Systems
 - Modified First Article
 - Final Acceptance KDI

Lithium Reserve Battery Automation Line



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SELF DESTRUCT BATTERY

MANUFACTURING PROCESS FLOW



Legend

Direction of Flow



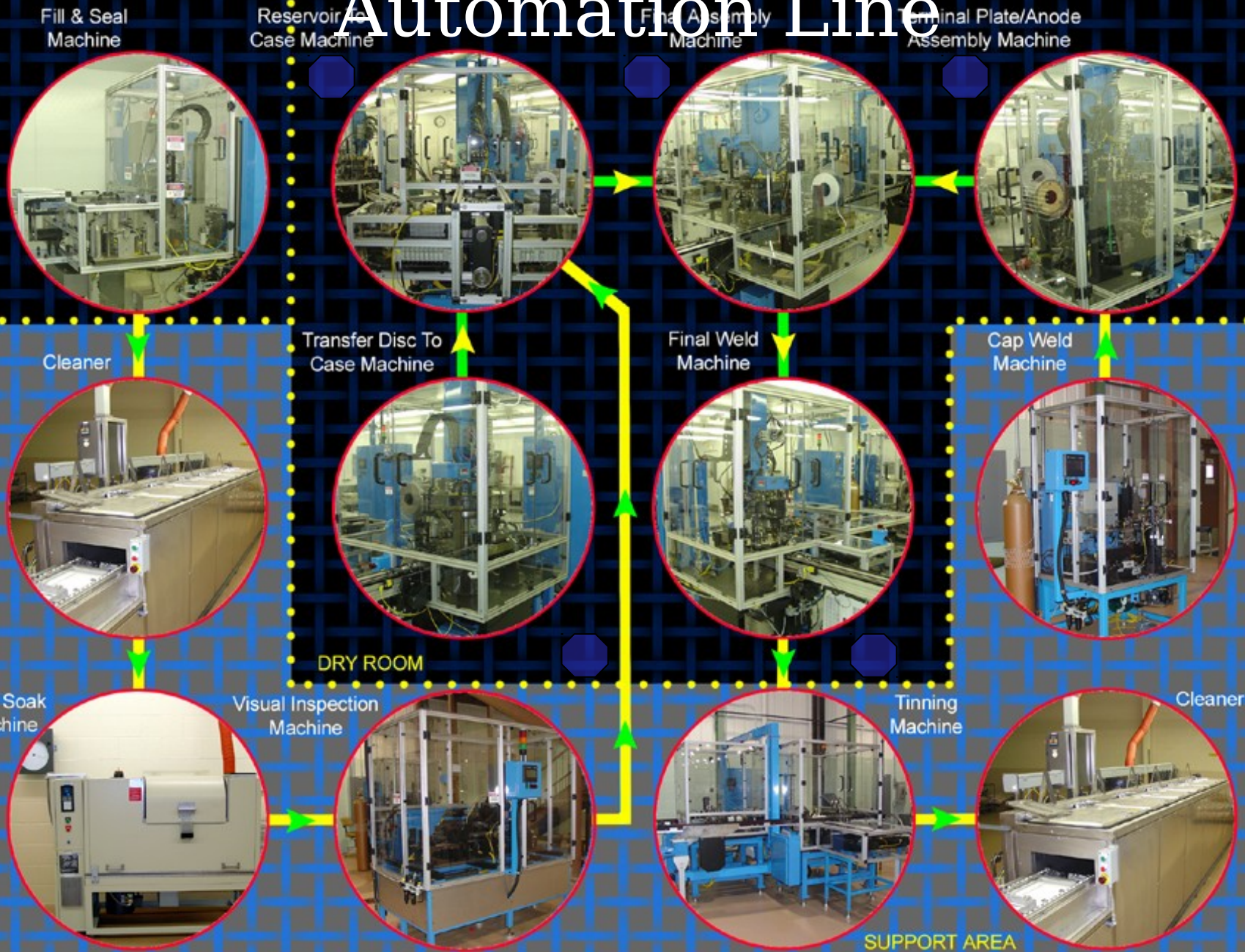
Dryroom



Manual Feed



Conveyor Feed



SDF (PIP)

- Two (2) Integrated Product Improvements
 - Packaged EED
 - Packaged IC

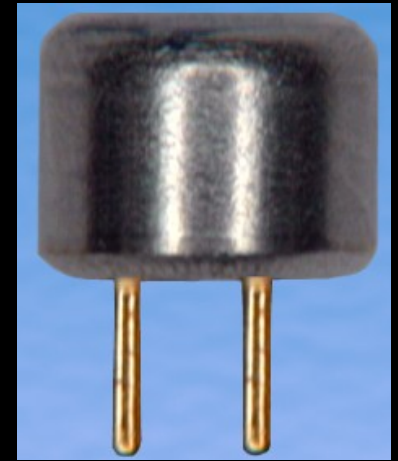
SDF (PIP) Current EED Design

- The Current EED Has Three (3) Explosive Elements That Are Loaded Into the Fuze and Consolidated
- After Consolidation, a Cover and Encapsulate Are Placed on Top of the Explosive Elements

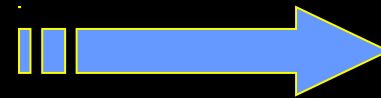


SDF (PIP) Packaged EED Design

- The Packaged EED Is a Two (2) Pin Hermetic Sealed Detonator



- The Packaged EED's are Inserted Into
- Receptacles That Are Surface Mounted on the PWB



SDF (PIP) Packaged EED

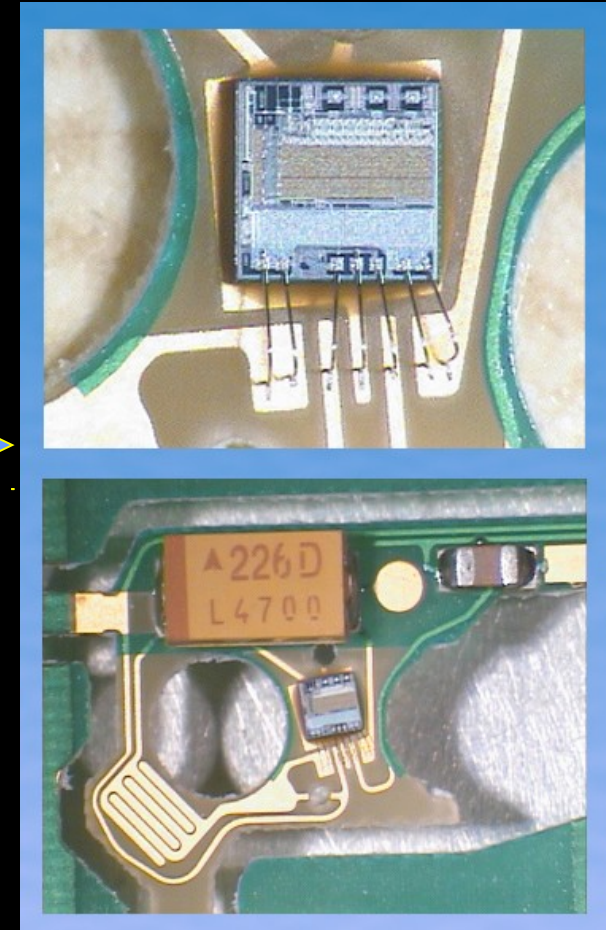
Advantages

- Reduces the Printed Wiring Board Complexity
- Assembly Process Is Less Complicated
- Lot Acceptance Can Be Performed at the Component Level
- Explosive Output Is 1.5 Times Greater
- Requires Less Energy to Fire



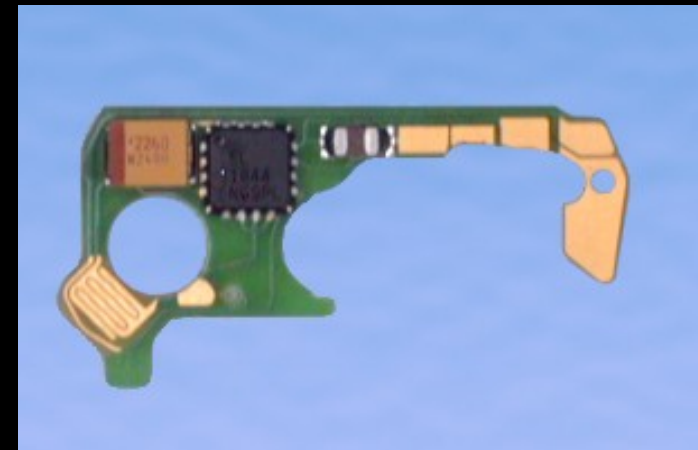
SDF (PIP) Current IC Assembly Design

- The Current PWB Employs Chip-on-Board (COB) Technology



SDF (PIP) Packaged IC Assembly Design

- The Packaged IC Design Contains the Same Die Which Is Placed in an Micro Lead frame Package



SDF (PIP) Packaged IC Advantages

- Assembly Is Greatly Simplified
- Increase in Throughput
- Increase in Yield
- Test at the Component Level
- Design Is More Robust

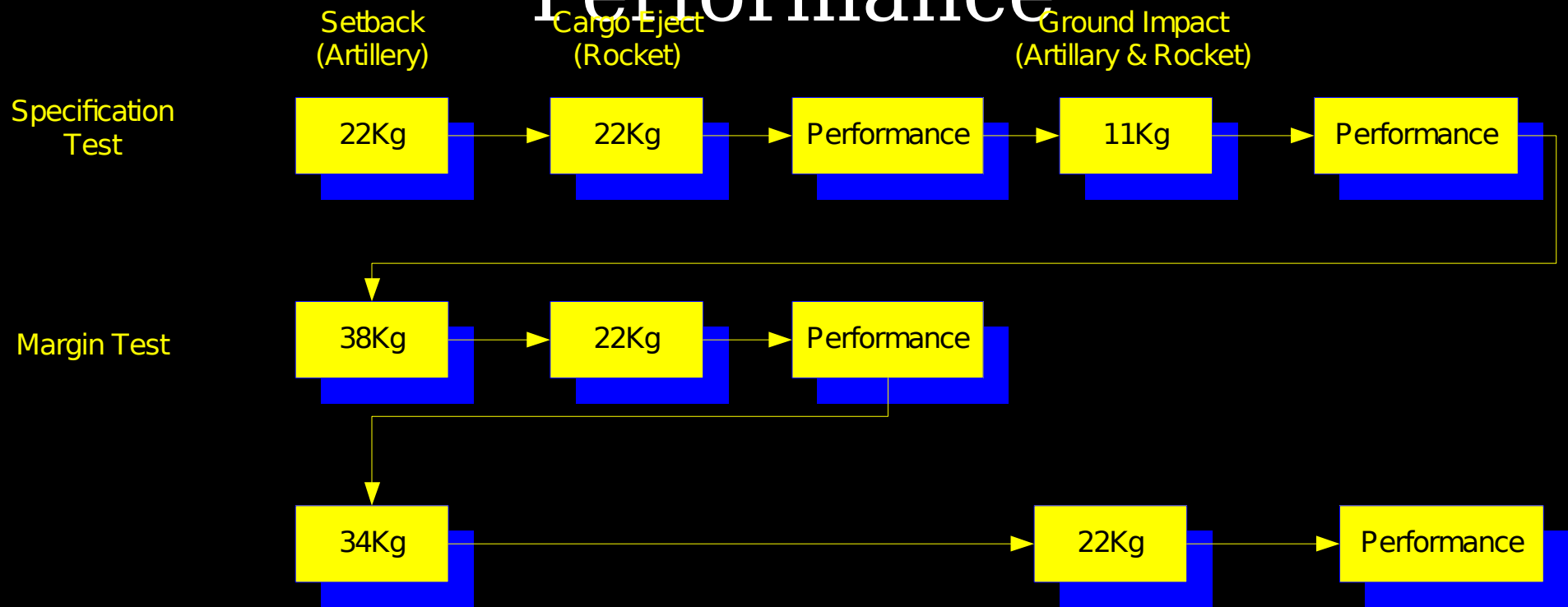


SDF (PIP) Test History

- Packaged EED  Qualified to MIL-I-23659 by USN
- Packaged IC  Structural Test to Confirm Robustness
- Flight Test 

Worst Case Environments

SDF (PIP) Packaged IC Structural Performance



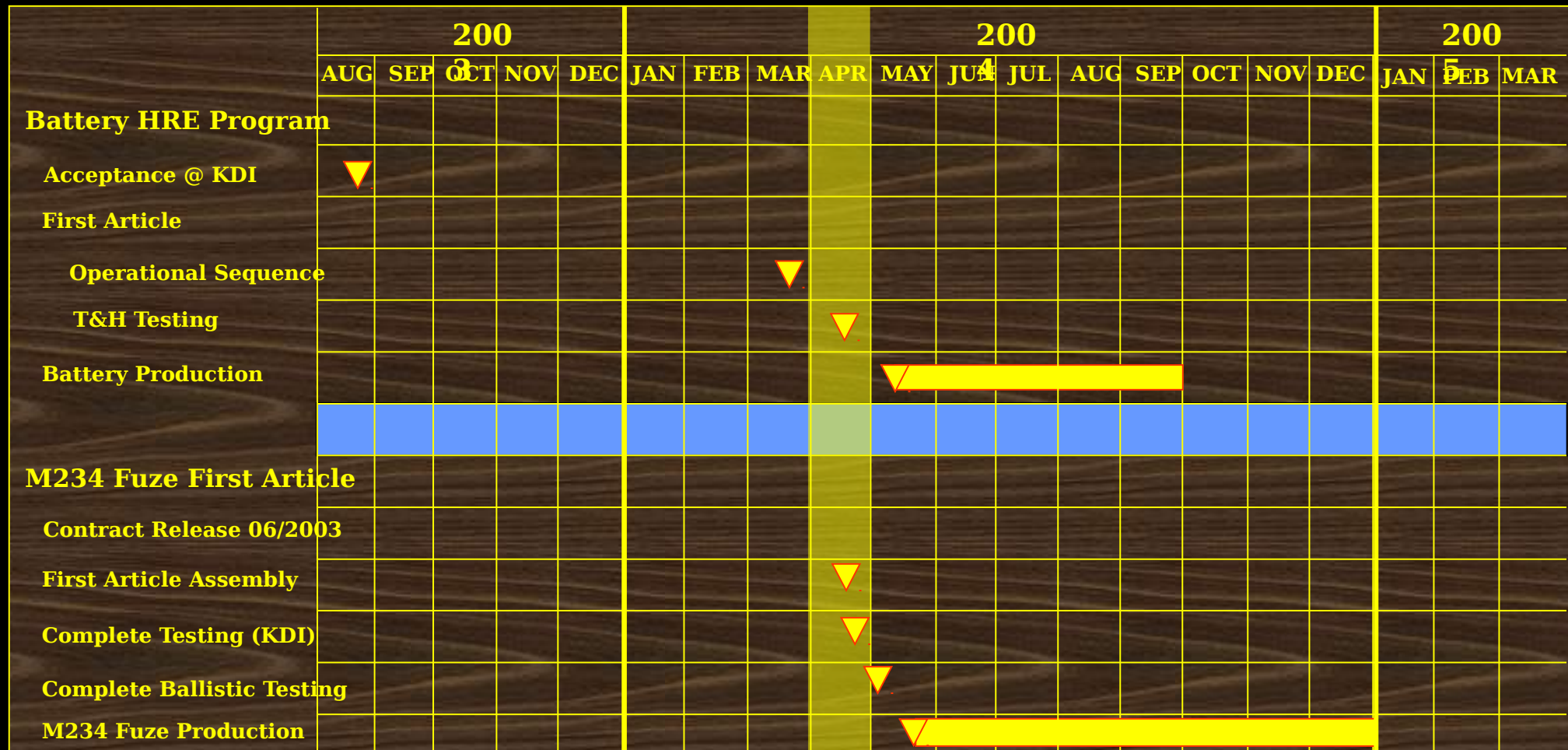
- Both Specification and Margin Test Were Performed on the Same Hardware Set
- Test Performed Following 160 Thermal Shock Cycles (Specification Requires Eight)

SDF Warm Line & GMLRS Fly Off Tests (PIP) Flight Test

• M915 Artillery		FVT: Performance 99.88% Flight: March 03
• M915 Artillery (Hot)		FVT: Performance 99.98% Flight: October 03
• M915 Artillery (Cold)		FVT: Performance 99.99% Flight: October 03
• GMLRS @ 16 Km		FVT: Performance 100% Flight: March 03
• GMLRS @ 20 Km		FVT: Performance 100% Flight: August 03
• GMLRS @ 65 Km (Hot)		FVT: Performance 100% Flight: December 03
• GMLRS @ 65 Km (Cold)		FVT: Performance 100% Flight: December 03
• GMLRS @ 19.5 Lm (Cold)		FVT: Performance 97% Flight: January 04

GMLRS Mission Reliability 97% UXO's & 99.6% Hazardous Duds

SDF Integrated Schedule



SDF Integrated Schedule

